INDOOR AIR QUALITY ASSESSMENT

Center Elementary School
837 Longmeadow Street
Longmeadow, MA 01106

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Center for Environmental Health
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of the Longmeadow Board of Health and faculty members of the Center Elementary School (CES), the Massachusetts Department of Public Health's (MDPH) Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality concerns at the CES, 837 Longmeadow Street, Longmeadow, Massachusetts. Ms. Beverly Hirschhorn, Longmeadow's Health Director, reported concerns of school staff regarding a suspected increase in cancer incidence among staff and concerns over a possible association with the school's indoor environment. Subsequently, Ms. Hirschhorn was asked to submit a written request with more detailed information to investigate the incidence of cancer at the CES.

On June 14, 2005, a visit to conduct an indoor air quality assessment was made to the CES by Cory Holmes, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Holmes was accompanied by Josh McHale, an Environmental Analyst in CEH's Community Assessment Program (CAP).

The CES consists of two, two-story buildings built in the early 1900s both with occupied basements. From 1995-1997, the buildings were renovated and an addition connecting the two buildings was constructed. The buildings contain general classrooms, community room, administrative offices, kindergarten classrooms, a pre-school common area, gymnasium, kitchen/cafeteria, music room, special education classrooms and storage areas and mechanical rooms. The connecting wing contains the library, computer room, teacher's workshop and storage areas. Windows are openable throughout the building. Select areas are provided with air conditioning (e.g., offices, library and computer room); classrooms throughout the school are not air conditioned.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). CEH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The school houses approximately 500 pre-kindergarten through fourth grade students and approximately 75 staff members. The tests were taken during normal operations at the school. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in six of thirty-nine areas, indicating adequate air exchange in the majority of areas surveyed. However, it is important to note that a number of areas with carbon dioxide levels below 800 ppm were sparsely populated, unoccupied and/or had windows open, which can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to be higher with full occupancy and windows closed.

Mechanical ventilation is provided by air-handling units (AHUs) located in mechanical rooms. Fresh air is continuously distributed via wall or ceiling-mounted air diffusers (Pictures 1 and 2) and ducted back to AHUs via ceiling or wall-mounted exhaust vents (Pictures 3 and 4). It is important to note that the location of some exhaust vents can limit exhaust efficiency. In several classrooms, exhaust vents are located above hallway doors (Picture 4). When classroom doors are open, exhaust vents will tend to draw air from both the hallway and the classroom, reducing the effectiveness of the exhaust vent to remove common environmental pollutants.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems reportedly occurred in 1995 during installation of new HVAC equipment.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded.

When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix A.

Temperature measurements ranged from 78° F to 89° F, which were above the MDPH recommended comfort range on the day of the assessment. These temperatures would be expected in a building without air conditioning with an outside temperature of 89° F at the time of assessment, and, open windows throughout the building. The MDPH recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. However, this is difficult to achieve without mechanical air conditioning. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Occupants in several areas voiced complaints of cold drafts in the vicinity of abandoned ventilation shafts in the corners of classrooms. These shafts may belong to an original gravity-feed ventilation system. They are ducted to the roof and may still be open to the elements (Picture 5). At the time of assessment, it was not clear whether the shafts are being used to vent the building. If these shafts are *not* currently being used to provide ventilation, they should be properly sealed to prevent the introduction of cold air down the shafts.

The relative humidity measured in the building ranged from 63 to 94 percent, which was above the MDPH recommended comfort range the day of the assessment. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. While temperature is mainly a comfort issue, relative humidity in excess of 70 percent for extended periods of time, can provide an environment for mold and fungal growth (ASHRAE, 1989). During periods of high relative humidity (late spring/summer months), windows and exterior doors should be closed as much as possible to keep moisture out. In addition, areas that are equipped with air conditioning should keep their doors shut to prevent conditioned air from entering the unconditioned hallways to prevent condensation on the cool surface of hallway floors.

Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A few areas had water stained ceiling tiles, which can indicate leaks from the roof or plumbing system or condensation from air conditioning components of the HVAC system. Water damaged porous building materials can provide a source for mold and should be replaced after a water leak is discovered and repaired.

Plants were observed in several classrooms. Plants, soil and drip pans can serve as sources of mold growth. Plants should be properly maintained, over-watering of plants should be avoided and drip pans should be inspected periodically for mold growth. Shrubbery and other plants were also seen growing in close proximity to exterior walls (Pictures 5 and 6). The growth of roots against the exterior walls can bring moisture in contact with wall brick. Plant roots can eventually penetrate the brick, leading to cracks and/or fissures in the below ground level foundation. Over time, this process can undermine the integrity of the building envelope, providing a means of water entry into the building through capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001).

CEH staff observed several breaches in the building envelope, such as crumbling or missing mortar in exterior brick and abandoned pipes/open utility holes (Pictures 8 and 9). Repeated water penetration can result in the chronic wetting of building materials and the potential for microbial growth. In addition large wall cracks/breaches may provide a means of egress for pests/rodents into the building.

Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, CEH staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect or ND (Table 1). Carbon monoxide levels measured in the school were also ND (Table 1).

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter (μg/m^3) in a 24-hour average (US EPA, 2000a). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standard requires outdoor air particle levels be maintained below 65 μg/m^3 over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

On the day of assessment, outdoor PM2.5 concentrations were measured at 96 μg/m^3 (Table 1), which were above the NAAQS of 65 μg/m^3. PM2.5 levels measured in the school ranged from 38 to 97 μg/m^3 (Table 1). According to the AirNow web site, outdoor PM2.5 concentrations for the Springfield, MA area the day of the assessment were moderate (51-100 μg/m^3) (AirNow, 2005). The U.S. EPA, NOAA, NPS, tribal, state, and local agencies developed the AirNow Web site to provide the public with easy access to national air quality information with links to daily air quality forecasts to more detailed state and local air quality web sites.

Frequently, indoor air levels of particulates can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulates during normal operation. Sources of indoor airborne particulate may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices, operating an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted throughout the facility. In light of vapor intrusion concerns from occupants, TVOC screening was also conducted several inches above the ground, around the perimeter of the building. Measurements were additionally taken from storm drains and utility holes that may serve as pathways/sources of soil VOCs and/or odors. All outdoor TVOC concentrations were ND (Table 1). Indoor TVOC concentrations throughout the building were also ND (Table 1).

In an effort to identify materials that can potentially increase indoor TVOC concentrations, CEH staff examined classrooms for products containing these respiratory irritants. Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. While no TVOCs were measured, materials containing VOCs were present in the school.

Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat. The teachers' workshop contains photocopiers and lamination machines. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). Lamination machines can produce irritating odors during use. This area is equipped with local exhaust ventilation; occupants should ensure that vents are operating to help reduce excess heat and odors.

Cleaning products were found on countertops and in unlocked cabinets beneath sinks in some classrooms. Like dry erase materials, cleaning products contain VOCs and other chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Also of concern are unlabelled bottles and containers. Products should be kept in their original containers and be clearly labeled for identification purposes, especially in the event of an emergency.

Several other conditions that can affect indoor air quality were noted during the assessment. Some classrooms had large cushions and/or pillows (Picture 10). These items are covered with fabric that comes in contact with human skin, which can leave oils, perspiration, hair and skin cells on the fabric. Dust mites feed upon human skin cells and excrete waste products that contain allergens. In addition, if relative humidity levels increase above 60 percent, dust mites tend to proliferate (US EPA, 1992).

Also of note was the amount of materials stored inside classrooms. Items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to the eyes, nose and respiratory tract. For this reason, items should be relocated and/or cleaned periodically to avoid excessive dust build up.

AHUs are normally equipped with filters that strain particulates from airflow. The filters at the CES provide low to medium filtration of respirable dusts (Picture 11). In order to decrease aerosolized particulates, use of disposable filters with an increased dust spot efficiency should be considered. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce airborne particulates (Thornburg, 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced by increased resistance, a condition known as pressure drop. Prior to any increase of filtration, AHUs should be evaluated by a ventilation engineer to ascertain whether they can maintain function with filters that are more efficient.

A few areas have window-mounted air conditioners (ACs). ACs are normally equipped with filters that should be cleaned/changed as per the manufacturer's instructions. Without cleaning/changing filters, the activation of these units can re-aerosolize dirt, dust and particulate, which can be irritating to certain individuals.

Finally, of note was the use of food containers for project materials (Picture 12). Exposed food products and reused food containers can attract a variety of pests. The presence of pests inside a building can produce conditions that can degrade indoor air quality. For example, rodent infestation can prompt symptoms due to materials in their wastes. Mouse urine is known to contain a protein that is a known sensitizer (US EPA, 1992). A sensitizer is a material that can produce symptoms in exposed individuals, including respiratory irritations and skin rashes. Pest attractants should be reduced/eliminated. Proper food storage is an integral component in maintaining indoor air quality. Reuse of food containers (e.g., for art projects) is not recommended since food residue adhering to the container surface may serve to attract pests.

Health Concerns

Information provided to the MDPH from local health officials relative to investigating cancer concerns among staff at the school included a list of 14 teachers (names not provided) who had been diagnosed with cancer. Information on the cancer type, date of diagnosis, age at diagnosis, current age, gender and approximate length of employment in the building was provided.

Ms. Hirschhorn wrote a follow-up letter in January 2005 to inform the CAP that the CES nurse learned of two retired long-term employees of the CES who had recently been diagnosed with breast cancer. No other information (e.g., date of diagnosis, age at diagnosis, dates of employment at the school) about these individuals was provided in the follow-up letter.

While at the school, Ms. Shebar clarified with Mr. McHale (MDPH, CAP) that the total number of CES staff members they were reporting with a diagnosis of cancer was 15 (not 16), as an individual was inadvertently counted twice by the CES. Ms. Shebar also provided Mr. McHale with additional information on all of the reported cancer diagnoses, including names and diagnostic information (e.g., primary site cancer, date of diagnosis, age at diagnosis). To determine the length of employment at the school prior to diagnosis, CAP staff obtained employment histories from the Longmeadow Superintendent's office. Following the MDPH visit for the IAQ evaluation, the CAP also requested information on the location of employment within the school (i.e., specific classrooms) for each of the individuals reported with a diagnosis of cancer. Although the CAP was not able to obtain information on the specific location (according to Nurse Ila Shebar, staff members frequently change classrooms), Ms. Shebar did provide the CAP with information about which of the two buildings each individual occupied throughout their employment at the CES.

CAP staff reviewed the most recent data available from the Massachusetts Cancer Registry (MCR) to confirm the cancer diagnoses reported among CES employees and to determine whether these diagnoses may represent an unusual pattern of cancer incidence. The MCR, a division within the MDPH Center for Health Information, Statistics, Research and Evaluation, is a population-based surveillance system that has been monitoring cancer incidence in the Commonwealth since 1982. All new diagnoses of invasive cancer, along with several types of in situ (non-invasive) cancer, among Massachusetts residents are required by law to be reported to the MCR within six months of the date of diagnosis (M.G.L. c.111. s 111b). This information is collected and kept in a confidential database. Data are collected on a daily basis and reviewed for accuracy and completeness on an annual basis. This process corrects misclassification of data (i.e., city/town misclassification) and deletes duplicate case reports.

Seven different primary types of cancer were reported by local health officials and school staff among 15 individuals who worked at the CES. A cancer diagnosis for ten of the 15 individuals was confirmed through the MCR. Among the ten individuals confirmed with cancer via the MCR, three different primary cancer diagnoses were identified including eight individuals with breast cancer, and two different types of cancer diagnosed in two individuals. (Note: to protect confidentiality, the types of cancer diagnosed in these two individuals will not be reported here).

CAP staff were not able to confirm the diagnoses of five of the 15 individuals reported to the CEH with cancer. Two of the five individuals were reported as having breast cancer while the other three individuals each had a different primary-site cancer according to information provided by the Longmeadow Health Director and the CES nurse. Although the MCR data for cancer diagnoses through the present time was reviewed, it is possible that some individuals diagnosed with cancer may not be included in the MCR files. Individuals with recent cancer diagnoses (e.g., 2004 and 2005) may not yet be reported to the MCR. Of the five individuals whose diagnoses could not be confirmed in the MCR, three were reported to the CEH with 2004 as their year of diagnosis. In addition, with the exception of benign brain tumors, individuals diagnosed with either pre-cancerous or non-cancerous conditions would not be included in the MCR data files. Finally, a diagnosis of cancer may not be correct for some individuals.

Eight of the ten individuals with a confirmed diagnosis were diagnosed with breast cancer and were diagnosed over an 11-year period. This suggests no unusual pattern with respect to date of diagnosis. Breast cancer is the most common type of cancer diagnosed among females in Massachusetts and the United States as a whole. Incidence rates of breast cancer increase notably among individuals aged 45 to 64 years. All staff members with a confirmed breast cancer diagnosis were in this age range at the time of their diagnosis.

It is also important to consider the latency period of a disease when trying to determine if a particular environmental exposure could have contributed to that disease outcome. Cancers in general have long periods of development or latency periods. A latency period is defined as the interval between first exposure to a disease-causing agent and the appearance of symptoms of the disease (Last, 1995). Cancer latency periods can range from 10 to 30 years and in some cases may be more than 40 to 50 years for solid tumors (Bang, 1996; Frumkin, 1995). Because of this, past exposures are more relevant than current exposures as potential risk factors for cancer. Although it is not possible to determine what may have caused any one person's diagnosis of cancer, the length of time in which an individual worked in a particular building can help determine the importance that their place of employment might have in terms of exposure to a potential environmental source. The shortest latency period for breast cancer is believed to be between 8 and 15 years (Lewis-Michl et al., 1996; Aschengrau, Paula, and Ozonoff, 1998; Petralia et al., 1999).

Using information provided by the Superintendent's Office, length of employment was examined for individuals with a confirmed cancer diagnosis. CAP staff did learn that the CES was renovated over a two year time period from 1995 to 1997. Among the eight individuals with breast cancer, their length of employment at the school varied. Importantly, one of the individuals with breast cancer was diagnosed before working at the CES eliminating the school's environment as contributing to the disease for this individual. Of the seven other staff members diagnosed with breast cancer, two individuals worked at the school for less than eight years prior to diagnosis, again suggesting that the school's indoor environment did not play a likely role. Three individuals were employed between nine and 14 years prior to their diagnosis of breast cancer. The remaining two individuals diagnosed with breast cancer worked in the school for more than 15 years before their diagnosis. (Note: During the two-year renovation period, the entire staff was relocated to another school building in the Longmeadow school system. For this analysis, however, we did not adjust length of employment to reflect the two years staff worked off-site).

Along with length of employment, location of employment in the school was also examined for the individuals diagnosed with breast cancer. As stated earlier, the CES consists of two buildings connected by a walkway. Although it was not possible to assign individuals to one specific room in a building, it was possible to classify individuals as having worked in a specific building or in both buildings during their employment at the school. Of the five individuals diagnosed with breast cancer who worked at the school longer than nine years, two staff members worked in both buildings of the CES, one individual worked in building 1, and the remaining two individuals worked in building 2. This does not indicate a pattern in actual location of employment that would suggest a common environmental factor in the school played a primary role in the development of cancer among these individuals.

A female's risk for developing breast cancer can change over time due to many factors, some of which are dependent upon well-established risk factors for this cancer type. Females with a family history of breast cancer, those who have never had children or had their first child after the age of 30, or those who take menopausal hormone therapy for more than five years are all at increased risk for developing breast cancer. The MCR database does not contain information about these personal risk factors. Despite the vast number of studies on the causation of breast cancer, known risk factors are estimated to account for approximately half of all diagnoses in the general population (Madigan et al., 1995). Researchers are continuing to examine other potential genetic, hormonal, and environmental risk factors for breast cancer. For more information on risk factors for breast cancer, please refer to Appendix B.

For the two individuals reported to the MCR who were not diagnosed with breast cancer, consideration was given as to whether any environmental risks factors have been reported in the epidemiologic literature for the two types of cancer. One cancer type is not thought to be associated with any environmental risk factors. For the second cancer type, exposure to specific environmental risk factors [i.e., trichloroethylene (TCE), cadmium and benzene] has been associated with an increased risk for developing the disease. However, such exposures generally occur in occupations that have regular, extended contact with these substances (e.g., chemical manufacturing). In addition, this cancer type has also been associated with other, non-environmental risk factors such as family history, pre-existing medical conditions, and tobacco use. Finally, the age at diagnosis for these two individuals was not unusual for their respective types of cancer.

Understanding that cancer is not one disease, but a group of diseases is also very important. Research has shown that there are more than 100 different types of cancer, each with different causative (or risk) factors. In addition, cancers of a certain tissue type in one organ may have a number of causes. Cancers may also be caused by one or several factors acting over time. For example, tobacco use has been linked to lung, bladder, and pancreatic cancers. Other factors related to cancer may include lack of crude fiber in the diet, high fat consumption, alcohol abuse, and reproductive history. Heredity, or family history, is an important risk factor for several cancers. To a lesser extent, some occupational exposures, such as jobs involving regular contact with asbestos, have been shown to cause specific cancers (e.g., asbestos exposure can cause mesothelioma). Environmental contaminants have also been associated with certain types of cancer (Bang, 1996; Frumkin, 1995).

According to American Cancer Society statistics, cancer is the second leading cause of death in Massachusetts and the United States. Not only will one out of three people develop cancer in their lifetime, but cancer will affect three out of every four families. For this reason, cancers often appear to occur in “clusters,” and it is understandable that someone may perceive that there are an unusually high number of cancer cases in their workplace, surrounding neighborhoods or towns. Upon close examination, many of these “clusters” are not unusual increases, as first thought, but are related to such factors as lifestyle, local population density, variations in reporting or chance fluctuations in occurrence. In other instances, the “cluster” in question includes a high concentration of individuals who possess related workplace exposures, behaviors or risk factors for cancer. Some, however, are unusual; that is, they represent a true excess of cancer in a workplace, a community, or among a subgroup of people. A suspected cluster is more likely to be a true cancer cluster if it involves a large number of cases of one type of cancer diagnosed in a relatively short time period rather than several different types diagnosed over a long period of time (i.e., 20 years), a rare type of cancer rather than common types, and/or a large number of cases diagnosed among individuals in age groups not usually affected by that cancer. These types of clusters may warrant further public health investigation.

Based upon our review of the available diagnosis information, length of employment, and IAQ test results, as well as the most current cancer literature, there does not appear to be an atypical pattern of cancer diagnoses among current and former employees of the CES in Longmeadow. That is, it does not appear that a common factor (either environmental or non-environmental) is likely related to the diagnosis of cancer among these individuals. Age at diagnosis among the ten employees whose diagnoses were confirmed in the MCR, was not different from the age pattern established for their respective cancer types. In addition, the eight individuals diagnosed with breast cancer occurred over an 11-year time period, indicating no temporal concentration of cases. Finally, while potential indoor air quality problems may have been noted in this report, these issues are not likely to be related to the incidence of cancer among employees at the CES, but probably have contributed to common symptoms associated with poor indoor air quality (e.g., headaches, fatigue and irritant symptoms).

Conclusions/Recommendations

The conditions noted at the CES raise a number of indoor air quality issues. In addition to the IAQ assessment, CEH staff also evaluated information in an attempt to identify possible environmental sources that could contribute to cancer development. No evidence of environmental sources associated with the diseases as identified in or around the building. A number of issues however, regarding general building conditions, design and routine maintenance that can affect indoor air quality were observed. These factors can be associated with a range of IAQ related health and comfort complaints (e.g., eye, nose, and respiratory irritations), but they are unlikely to be associated with cancer occurrences among employees. In view of the findings at the time of the visit, the following recommendations are made:

1. Operate all ventilation systems throughout the building (e.g., gym, auditorium, classrooms) continuously during periods of school occupancy to maximize air exchange.
2. Use openable windows in conjunction with classroom univents and exhaust vents to increase air exchange. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.
3. Consider developing a written notification system for building occupants to report indoor air quality issues/problems. Have these concerns relayed to the maintenance department/building management in a manner that allows for a timely remediation of the problem. An example is included as Appendix C.
4. Determine whether original exhaust ventilation shafts are in use. If not these shafts should be properly sealed to prevent drafts into the building.
5. Close classroom doors to improve air exchange.

6. Consider adopting a balancing schedule of every 5 years for mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).
8. Ensure leaks are repaired and replace/remove water damaged ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
9. Examine plants in classrooms for mold growth in water catch basins. Disinfect water catch basins if necessary.
10. Remove plants growing against building and its foundation to prevent water intrusion through brickwork.
11. Seal breaches around pipes and seal cracks in exterior brick and mortar to prevent water infiltration and pest entry.
12. Change filters for *all* air-handling equipment (e.g., AHUs and ACs) as per the manufacturer's instructions or more frequently if needed. Vacuum interior of units prior to activation to prevent the aerosolization of dirt, dust and particulates.

13. Consider increasing the dust-spot efficiency of HVAC filters. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer as to whether it can maintain function with more efficient filters.
14. Store cleaning products properly and out of reach of students. Ensure spray bottles are properly labeled in case of emergency.
15. Refrain from using food containers as materials for projects.
16. Consider adopting the US (2000b) EPA document, "Tools for Schools", to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at: http://www.epa.gov/iaq/schools/index.html.
17. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. Copies of these materials are located on the MDPH's website: http://mass.gov/dph/indoor_air

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Picture 1

Ceiling-Mounted Supply Vent

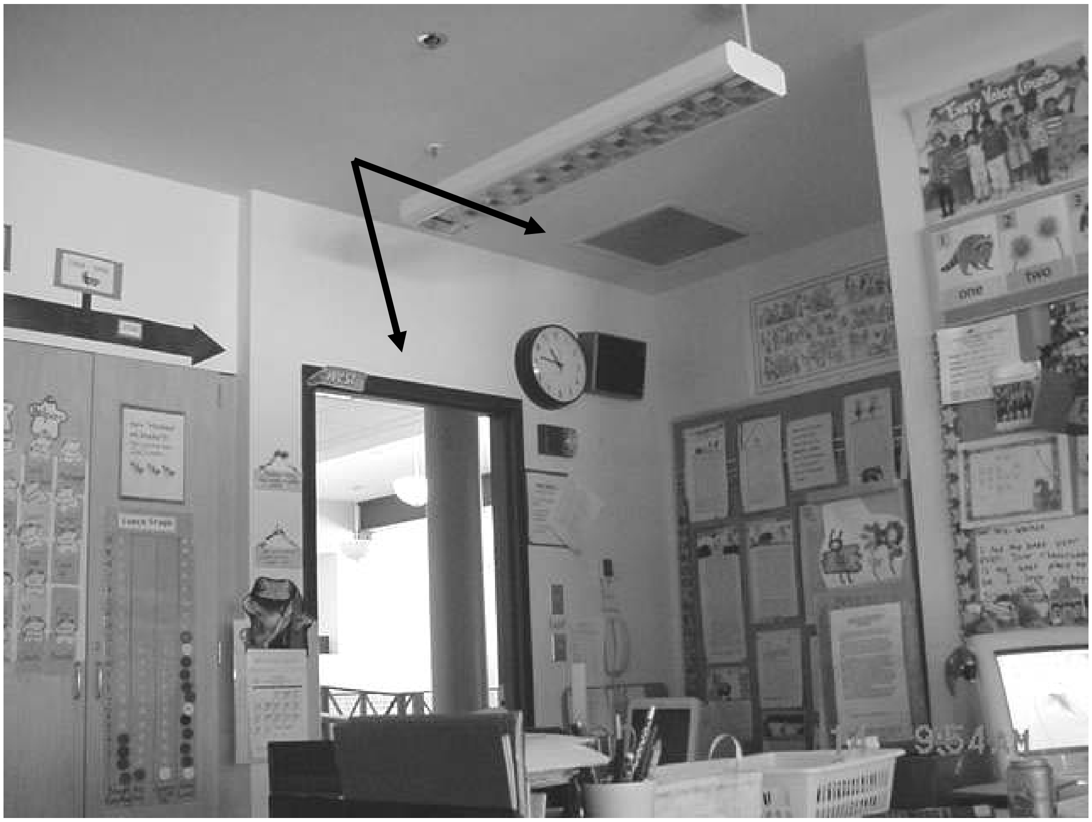
Picture 2

Wall-Mounted Supply Vent

Picture 3

Wall-Mounted Return Vent

Picture 4



Ceiling-Mounted Return Vent, Note open Classroom Door

Picture 5

Rooftop Ventilation Shaft

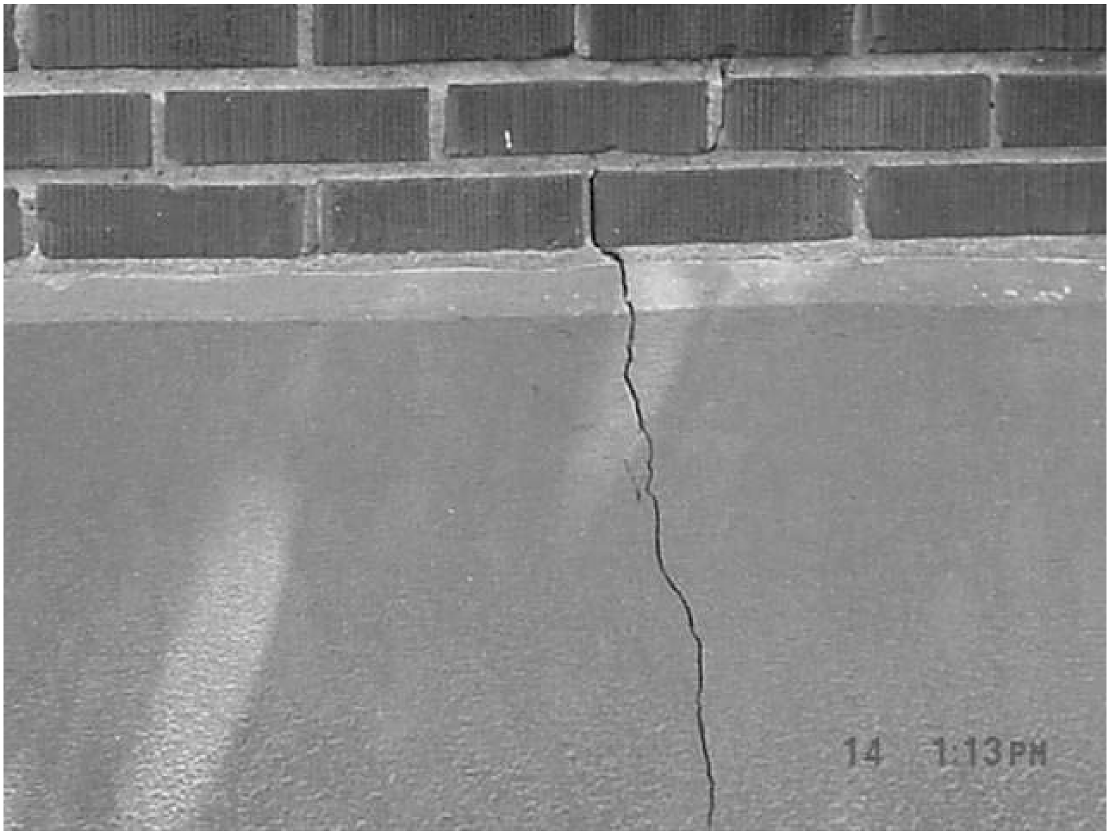
Picture 6

Trees and Shrubbery against Exterior Brickwork

Picture 7

Plants Growing in Seams along Exterior Walls

Picture 8



Crack in Foundation

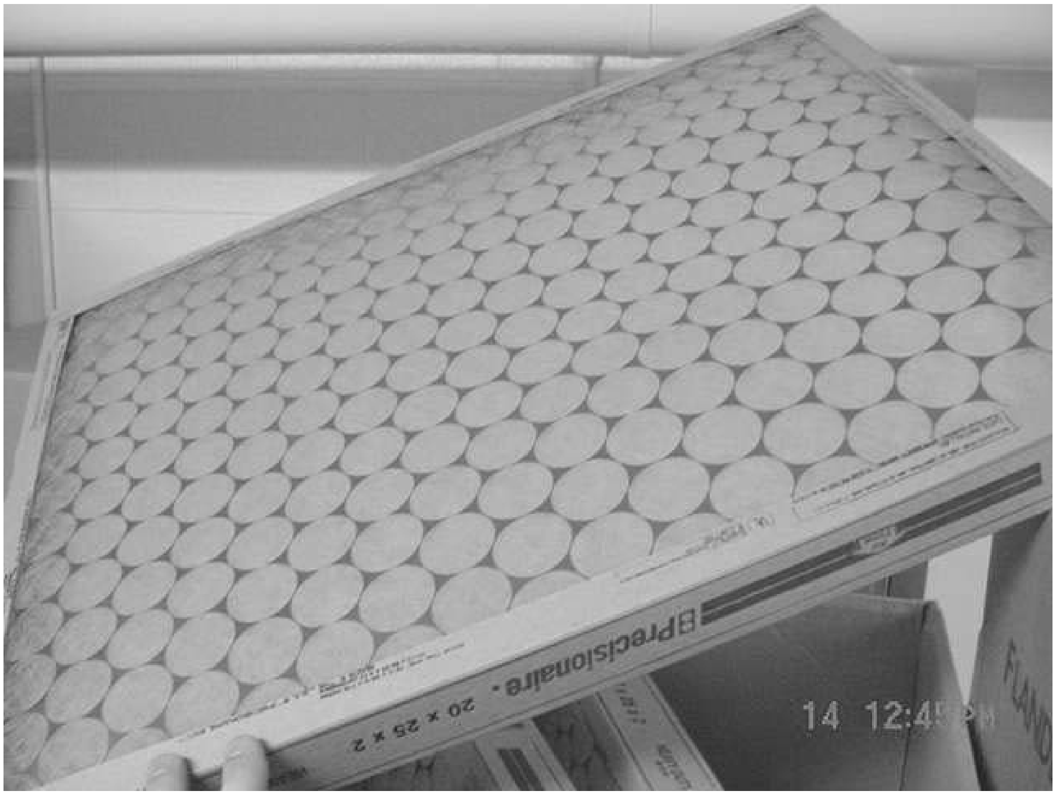
Picture 9

Abandoned Pipes/Utility Holes

Picture 10

Floor Pillows and Cushions

Picture 11



AHU Filter

Picture 12

Empty Pizza Boxes on Floor of Classroom

Center Elementary School **Indoor Air Results**

837 Longmeadow St, Longmeadow, MA 01106 **Date: 06/14/2005**

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
background		89	78	448	ND	ND	96				hot, humid, winds light and variable, moderate traffic .
A 101	2	87	69	546	ND	ND	58	Y # open: 0 # total: 5	Y wall	Y ceiling	Hallway DO, DEM, PF, cleaners, plants
A 102	0	87	87	406	ND	ND	55	Y # open: 3 # total: 4	Y	Y	Hallway DO, Inter-room DO, DEM, PF, plants, occupants at lunch, hanging plants over carpet.
A 103	2	89	85	477	ND	ND	53	Y # open: 5 # total: 6	Y wall	Y ceiling	Hallway DO, WD-ceiling, DEM, items.
A 104	0	88	83	464	ND	ND	48	Y # open: 5 # total: 6	Y wall	Y ceiling	Hallway DO, DEM, PF, plants.
A 105	0	89	63	592	ND	ND	46	N # open: 0 # total: 3	Y wall	Y ceiling	Hallway DO, window-mounted AC, DEM.

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials

design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile

NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings

sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Center Elementary School **Indoor Air Results**

837 Longmeadow St, Longmeadow, MA 01106 **Date: 06/14/2005**

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
A 106	0	88	91	510	ND	ND	51	Y # open: 4 # total: 4	Y wall	Y ceiling	Hallway DO, DEM.
A 107	2	89	83	521	ND	ND	51	Y # open: 4 # total: 5	Y wall	Y ceiling	Hallway DO, PF.
A 201	0	89	91	479	ND	ND	38	Y # open: 8 # total: 8	Y ceiling	Y ceiling	Hallway DO, DEM, PF, cleaners.
A 202	0	89	82	483	ND	ND	38	Y # open: 2 # total: 6	Y ceiling	Y ceiling	Hallway DO, Inter-room DO, DEM, PF, plants.
A 203	8	89	82	521	ND	ND	41	Y # open: 0 # total: 3			Inter-room DO, window-mounted AC, DEM.
A 204	0	89	83	497	ND	ND	42	Y # open: 3 # total: 4	Y	Y ceiling	Hallway DO, broken window pane.

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Center Elementary School | **Indoor Air Results**

837 Longmeadow St, Longmeadow, MA 01106 | **Date: 06/14/2005**

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Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
art	1	88	81	500	ND	ND	44	Y # open: 5 # total: 6	Y ceiling	Y ceiling	Hallway DO, 18 occupants gone 2 min, AC-on/window open.
C 001	22	80	83	804	ND	ND	56	Y # open: 0 # total: 4	Y wall	Y ceiling (off)	Hallway DO, DEM, PF, plants, exhaust off-reports of backdrafting in winter.
C 002	23	82	83	787	ND	ND	58	Y # open: 0 # total: 4	Y wall	Y ceiling	Hallway DO, PF, plants.
C 003	25	82	94	864	ND	ND	60	Y # open: 4 # total: 4	Y wall	Y ceiling	Hallway DO.
C 004	21	82	89	855	ND	ND	58	Y # open: 4 # total: 4	Y wall	Y ceiling (off)	No draw exhaust, hallway DO, DEM, plants
C 101	6	86	85	540	ND	ND	96	N	Y ceiling	Y wall	Hallway DO,

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Center Elementary School

837 Longmeadow St, Longmeadow, MA 01106

Indoor Air Results

Date: 06/14/2005

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									Supply	Exhaust	
C 102	0	87	82	631	ND	ND	97	Y # open: 4 # total: 4	Y ceiling	Y ceiling	DEM, dust complaints, poor air exchange complaints.
C 103	17	88	89	682	ND	ND	94	Y # open: 0 # total: 4	Y	Y	DEM, PF, cleaners, temperature complaints (cold), temperature complaints (hot), broken window, complaints of cold drafts from shaft in corner of room.
C 104	2	82	87	718	ND	ND	71	N	Y ceiling	Y wall	Hallway DO,
C 104	2	88	87	627	ND	ND	82	Y # open: 2 # total: 2	Y ceiling	Y	temperature complaints (cold), temperature complaints (hot), exposed fiberglass.

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Center Elementary School **Indoor Air Results**

837 Longmeadow St, Longmeadow, MA 01106 **Table 1** **Date: 06/14/2005**

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C 106	19	88	87	870	ND	ND	80	Y # open: 3 # total: 4	Y wall	Y ceiling	stuffed pillows.
C 107	21	89	83	618	ND	ND	63	Y # open: 3 # total: 4	Y wall	Y ceiling	Hallway DO, DEM, 4 CT
C 110	1	87	83	450	ND	ND	62	Y # open: 3 # total: 4	Y wall	Y ceiling	Hallway DO, DEM, PF.
C 111	0	87	74	460	ND	ND	62	Y # open: 3 # total: 4	Y wall	Y ceiling	Hallway DO, DEM, 4 CT
C 201	0	89	83	496	ND	ND	62	Y # open: 4 # total: 4	Y ceiling	Y ceiling	Hallway DO, PF, cleaners.
C 202	12	88	84	523	ND	ND	65	Y # open: 5 # total: 5	Y ceiling	Y ceiling	Hallway DO, PF.

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Indoor Air Results

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									Supply	Exhaust	
C 203	19	89	89	700	ND	ND	67	Y # open: 0 # total: 4	Y ceiling	Y ceiling	DEM.
C 204	0	87	90	485	ND	ND	68	Y # open: 4 # total: 4	Y ceiling	Y ceiling	Hallway DO, PF, plants.
C 205	22	89	88	564	ND	ND	68	Y # open: 3 # total: 4	Y ceiling	Y ceiling	Hallway DO, DEM, broken window, damaged carpeting, ceiling fan.
C 206	19	89	84	600	ND	ND	70	Y # open: 0 # total: 4	Y ceiling	Y wall	Hallway DO, Inter-room DO, DEM.
cafeteria	50	85	85	475	ND	ND	62	N			
computer room	23	79	84	900	ND	ND	40	N	Y ceiling	Y ceiling	Hallway DO, DEM.

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gym	100	86	89	520	ND	ND	53	N	Y wall	Y wall	Exterior DO,
library	40	79	89	875	ND	ND	39	N	Y ceiling	Y ceiling	Hallway DO, DEM, plants.
music	0	78	88	567	ND	ND	48	Y # open: 0 # total: 8	Y wall	Y ceiling	
nurse	5	80	80	685	ND	ND	61	Y # open: 0 # total: 1	Y ceiling	Y ceiling	Hallway DO, #WD-CT: 3.
pre school common	0	85	80	504	ND	ND	49	N	Y ceiling		Hallway DO, #WD-CT: 9.
teacher's workshop	0	81	78	675	ND	ND	45	N # open: 0 # total: 0	Y ceiling	Y ceiling	#WD-CT: 4, PC, laminator.

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Appendix B

Risk Factor Information for Breast Cancer

Breast cancer is the most frequently diagnosed cancer among women in both the United States and in Massachusetts. According to the North American Association of Central Cancer Registries, female breast cancer incidence in Massachusetts is the fifth highest among all states (Chen et al, 2000). Although during the 1980s breast cancer in the U.S. increased by about 4% per year, the incidence has leveled off to about 110.6 cases per 100,000 (ACS 2000). A similar trend occurred in Massachusetts and there was even a slight decrease in incidence (1%) between 1993 and 1997 (MCR 2000).

In the year 2005, approximately 211,240 women in the U.S. will be diagnosed with breast cancer (ACS 2005). Worldwide, female breast cancer incidence has increased, mainly among women in older age groups whose proportion of the population continues to increase as well (van Dijck, 1997). A woman's risk for developing breast cancer can change over time due to many factors, some of which are dependent upon the well-established risk factors for breast cancer. These include increased age, an early age at menarche (menstruation) and/or late age at menopause, late age at first full-term pregnancy, family history of breast cancer, and high levels of estrogen. Other risk factors that may contribute to a woman's risk include benign breast disease and lifestyle factors such as diet, body weight, lack of physical activity, consumption of alcohol, and exposure to cigarette smoke. Data on whether one's risk may be affected by exposure to environmental chemicals or radiation remains inconclusive. However, studies are continuing to investigate these factors and their relationship to breast cancer.

Family history of breast cancer does affect one's risk for developing the disease. Epidemiological studies have found that females who have a first-degree relative with premenopausal breast cancer experience a 3-fold greater risk. However, no increase in risk has been found for females with a first degree relative with postmenopausal breast cancer. If women have a first-degree relative with bilateral breast cancer (cancer in both breasts) at any age then their risk increases five-fold. Moreover, if a woman has a mother, sister or daughter with bilateral premenopausal breast cancer, their risk increases nine fold. (Broeders and Verbeek, 1997). In addition, twins have a higher risk of breast cancer compared to non-twins (Weiss et al, 1997).

A personal history of benign breast disease is also associated with development of invasive breast cancer. Chronic cystic or fibrocystic disease is the most commonly diagnosed benign breast disease. Women with cystic breast disease experience a 2-3 fold increase in risk for breast cancer (Henderson et al, 1996).

According to recent studies, approximately 10% of breast cancers can be attributed to inherited mutations in breast cancer related genes. Most of these mutations occur in the BRCA1 and BRCA2 genes. Approximately 50% to 60% of women who inherit BRCA1 or BRCA2 gene mutations will develop breast cancer by the age of 70 (ACS 2001).

Cumulative exposure of the breast tissue to estrogen and progesterone hormones may be one of the greatest contributors to risk for breast cancer (Henderson et al, 1996). Researchers suspect that early exposures to a high level of estrogen, even during fetal development, may add to one's risk of developing breast cancer later in life. Other studies have found that factors associated with increased levels of estrogen (i.e., neonatal jaundice, severe prematurity, and being a fraternal twin) may contribute to an elevated risk of developing breast cancer (Ekbom et al, 1997). Conversely, studies have revealed that women whose mothers experienced toxemia during pregnancy (a condition associated with low levels of estrogen) had a significantly reduced risk of developing breast cancer. Use of estrogen replacement therapy is another factor associated with increased hormone levels and it has been found to confer a modest (less than two-fold) elevation in risk when used for 10-15 years or longer (Kelsey, 1993). Similarly, more recent use of oral contraceptives or use for 12 years or longer seems to confer a modest increase in risk for bilateral breast cancer in premenopausal women (Ursin et al, 1998).

Cumulative lifetime exposure to estrogen may also be increased by certain reproductive events during one's life. Women who experience menarche at an early age (before age 12) have a 20% increase in risk compared to women who experience menarche at 14 years of age or older (Broeders and Verbeek, 1997; Harris et al, 1992). Women who experience menopause at a later age (after the age of 50) have a slightly elevated risk for developing the disease (ACS 2001). Furthermore, the increased cumulative exposure from the combined effect of early menarche and late menopause has been associated with elevated risk (Lipworth, 1995). In fact, women who have been actively menstruating for 40 or more years are thought to have twice the risk of developing breast cancer than women with 30 years or less of menstrual activity (Henderson et al, 1996). Other reproductive events have also shown a linear association with risk for breast cancer (Wohlfahrt, 2001). Specifically, women who gave birth for the first time before age 18 experience one-third the risk of women who have carried their first full-term pregnancy after age 30 (Boyle et al, 1988). The protective effect of earlier first full-term pregnancy appears to result from the reduced effect of circulating hormones on breast tissue after pregnancy (Kelsey, 1993).

Diet, and particularly fat intake, is another factor suggested to increase a woman's risk for breast cancer. Currently, a hypothesis exists that the type of fat in a woman's diet may be more important than her total fat intake (ACS 1998; Wynder et al, 1997). Monounsaturated fats (olive oil and canola oil) are associated with lower risk while polyunsaturated (corn oil, tub margarine) and saturated fats (from animal sources) are linked to an elevated risk. However, when factoring in a woman's weight with her dietary intake, the effect on risk becomes less clear (ACS 1998). Many studies indicate that a heavy body weight elevates the risk for breast cancer in postmenopausal women (Kelsey, 1993), probably due to fat tissue as the principal source of estrogen after menopause (McTiernan, 1997). Therefore, regular physical activity and a reduced body weight may decrease one's exposure to the hormones believed to play an important role in increasing breast cancer risk (Thune et al, 1997).

Aside from diet, regular alcohol consumption has also been associated with increased risk for breast cancer (Swanson et al, 1996; ACS 2001). Women who consumed one alcoholic beverage per day experienced a slight increase in risk (approximately 10%) compared to non-drinkers, however those who consumed 2 to 5 drinks per day experienced a 1.5 times increased risk (Ellison et al., 2001; ACS 2001). Despite this association, the effects of alcohol on estrogen metabolism have not been fully investigated (Swanson et al, 1996).

To date, no specific environmental factor, other than ionizing radiation, has been identified as a cause of breast cancer. The role of cigarette smoking in the development of breast cancer is unclear. Some studies suggest a relationship between passive smoking and increased risk for breast cancer; however, confirming this relationship has been difficult due to the lack of consistent results from studies investigating first-hand smoke exposure (Laden and Hunter, 1998).

Studies on exposure to high doses of ionizing radiation demonstrate a strong association with breast cancer risk. These studies have been conducted in atomic bomb survivors from Japan as well as patients that have been subjected to radiotherapy in treatments for other conditions (i.e., Hodgkin's Disease, non-Hodgkin's Lymphoma, tuberculosis, post-partum mastitis, and cervical cancer) (ACS 2001). However, it has not been shown that radiation exposures experienced by the general public or people living in areas of high radiation levels, from industrial accidents or nuclear activities, are related to an increase in breast cancer risk (Laden and Hunter, 1998). Investigations of electromagnetic field exposures in relation to breast cancer have been inconclusive as well.

Occupational exposures associated with increased risk for breast cancer have not been clearly identified. Experimental data suggests that exposure to certain organic solvents and other chemicals (e.g., benzene, trichloropropane, vinyl chloride, polycyclic aromatic hydrocarbons (PAHs)) causes the formation of breast tumors in animals and thus may contribute to such tumors in humans (Goldberg and Labreche, 1996). Particularly, a significantly elevated risk for breast cancer was found for young women employed in solvent-using industries (Hansen, 1999). Although risk for premenopausal breast cancer may be elevated in studies on the occupational exposure to a combination of chemicals, including benzene and PAHs, other studies on cigarette smoke (a source of both chemicals) and breast cancer have not shown an associated risk (Petralia et al, 1999). Hence, although study findings have yielded conflicting results, evidence does exist to warrant further investigation into the associations.

Other occupational and environmental exposures have been suggested to confer an increased risk for breast cancer in women, such as exposure to polychlorinated biphenyls (PCBs), chlorinated hydrocarbon pesticides (DDT and DDE), and other endocrine-disrupting chemicals. Because these compounds affect the body's estrogen production and metabolism, they can contribute to the development and growth of breast tumors (Davis et al, 1997; Holford et al, 2000; Laden and Hunter, 1998). However, studies on this association have yielded inconsistent results and follow-up studies are ongoing to further investigate any causal relationship (Safe, 2000).

When considering a possible relationship between any exposure and the development of cancer, it is important to consider the latency period. Latency refers to the time between exposure to a causative factor and the development of the disease outcome, in this case breast cancer. It has been reported that there is an 8 to 15 year latency period for breast cancer (Petralia 1999; Aschengrau 1998; Lewis-Michl 1996). That means that if an environmental exposure were related to breast cancer, it may take 8 to 15 years after exposure to a causative factor for breast cancer to develop.

Socioeconomic differences in breast cancer incidence may be a result of current screening participation rates. Currently, women of higher socioeconomic status (SES) have higher screening rates, which may result in more of the cases being detected in these women. However, women of higher SES may also have an increased risk for developing the disease due to different reproductive patterns (i.e., parity, age at first full-term birth, and age at menarche). Although women of lower SES show lower incidence rates of breast cancer in number, their cancers tend to be diagnosed at a later stage (Segnan, 1997). Hence, rates for their cancers may appear lower due to the lack of screening participation rather than a decreased risk for the disease. Moreover, it is likely that SES is not in itself the associated risk factor for breast cancer. Rather, SES probably represents different patterns of reproductive choices, occupational backgrounds, environmental exposures, and lifestyle factors (i.e., diet, physical activity, cultural practices) (Henderson et al, 1996).

Despite the vast number of studies on the causation of breast cancer, known factors are estimated to account for less than half of breast cancers in the general population (Madigan et al, 1995). Researchers are continuing to examine potential risks for developing breast cancer, especially environmental factors.

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Appendix C

BEDFORD PUBLIC SCHOOLS

TOWN OF BEDFORD

WORK ORDER

REPAIR # ________

DATE: __________ TIME: ____________

- ☐ ROUTINE
- ☐ EMERGENCY
- ☐ VIOLATION
- ☐ PROJECT

REQUESTED BY: ext.

APPROVED BY: ext.

SCHOOL/BUILDING

MACHINE # | Room #

DESCRIPTION OF PROBLEM:

LIST BELOW ACTUAL WORK DONE:

DONE BY: DATE:	INITIALS	WORK TIME: HRS.	MIN.

NOTES:

CREW ASSIGNMENTS:
- ☐ 00. MAINT. TECH.
- ☐ 01. HVAC TECH
- ☐ 02. CARPENTER
- ☐ 03. ELECTRICIAN
- ☐ 04. PLUMBER
- ☐ 05. PAINTER
- ☐ 06. CUSTODIAN
- ☐ 07. SUPERVISOR
- ☐ 08. DRIVER
- ☐ 09. SECRETARY
- ☐ 10. OTHER

CAUSE:
- ☐ 0. PM DIRECTED
- ☐ 1. PREV. MAINT.
- ☐ 2. FAILURE
- ☐ 3. VANDALISM
- ☐ 4. PROJECT
- ☐ 5. SAFETY
- ☐ 6. TRAINING
- ☐ 7. ADMINISTRATION
- ☐ 8. TOILET/ DRAIN PROB
- ☐ 9. CIRCUIT BREAKER
- ☐ A. OTHER

MATERIALS

LINE	QUANTITY	DESCRIPTION	COST
		TOTAL:	

SUPERVISION USE ONLY

WAITING FOR PARTS	SCHEDULE
PURCH. ORDER #:	START:
DATE ORDERED:	COMPLETE:
DATE RECEIVED:	REVIEWED:

White - Facilities Dept./Yellow - Return to Issuer/Pink - School or Dept. Requesting